PROCEEDINGS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY,

HELD AT PHILADELPHIA, FOR PROMOTING USEFUL KNOWLEDGE.

VOL. XXII. 1884. No. 117.

The Extinct Mammalia of the Valley of Mexico. By E. D. Cope.

(Read before the American Philosophical Society, May 16, 1884.)

The following study is based primarily on an examination of the specimens contained in the Museum Nacional of Mexico, which I was permitted to make through the kindness of the Director of the Departments of Geology and Mineralogy, Professor Mariano Barcena. Through the mediation of the same gentleman, I obtained permission from Professor Antonio Castillo, Director of the School of Mines, to examine the corresponding material preserved in the fine museum of that institution. The knowledge derived from the study of the latter, reinforced the results I obtained from the study of the specimens of the Museum Nacional, so as to enable me to reach definite conclusions as to the definitions of various species which are represented in both collections. I wish to record the obligations under which I have been laid by both of these distinguished gentlemen. I have, through their aid, been enabled to make a comparison between the pliocene fauna of Mexico, and that of Buenos Ayres, and that of Oregon. The species of the Pampean fauna contained in my private collection, are those exhibited by Messrs. Ameghino, Larroque and Brachet, at the Exposition of Paris of 1878. My Oregon material is derived from the explorations of my parties under Messrs. Sternberg and Duncan, and those of Professor Thomas Condon of the University of Oregon, who kindly lent me his collection.

The collections of the museums of the City of Mexico, above mentioned, are derived from the locality Tequixquiac, and the specimens referred to in the following pages are to be understood as having been derived from that locality unless otherwise stated. Tequixquiac is situated on the northern edge of the valley of Mexico, north of the City of Mexico and the town of Zimpango, and east of the gorge of Nochistongo.

GLYPTODON Owen.

GLYPTODON, sp. indet.

A nearly complete carapace of this remarkable animal is mounted in the Museum Nacional, and a second, nearly as well preserved, is in the Museum of the School of Mines. Jaws and teeth occur in the latter museum. The discovery of this genus at this extreme northern locality is due to Dr. Antonio Castillo. It was first announced by Dr. Mariano Barcena in the Revista Cientifica of Mexico, 1882, I, p. 3. The extension of this far southern genus to the latitude of Mexico during the Pliocene (Pampean) epoch, is entirely consistent with the further distribution of the great sloths and llamas to the United States at the same time.

DIBELODON Cope.

Mastodon pars, auctorum.

Various attempts have been made to define as genera groups of species which are included within the limits of the genus Mastodon of authors. The first new name, Tetracaulodon, was introduced by Dr. Godman, who saw in the mandibular tusks of some individuals of the *Mastodon americanus* Cuv., ground of its separation from the genus Mastodon, in which he believed those teeth to be wanting. This division was adopted by Dr. Grant and others, but has not been generally allowed. The next division was that proposed by Dr. Falconer, who, however, did not employ the names proposed by him in more than a subgeneric sense. He distinguished two series in the genus Mastodon. In one of these, the P-m. 3, and the Ms. 1 and 2 present three transverse crests, while in the other division these teeth present four such crests. To these divisions he gave the names of Trilophodon and Tetralophodon respectively. The third attempt at division is that of Herr Vacek, who gives names to the two divisions of the genus in which the cross-crests are composed of tubercles or continuous ridges. These divisions he calls Bunolophodon and Zygolophodon respectively.*

I will refer to these divisions in reversed order. Those proposed by Vacek cannot be regarded as genera, and their author did not use them as such. The tubercular crest passes into the straight crest by insensible stages. The divisions proposed by Falconer are more distinct, but not sufficiently so to represent genera. This may be understood by reference to the second lower molar of the *Mastodon augustidens*, which is, in some individuals, three crested, and in others four crested. Some other species present the same difficulty. On this point I quote the remarks of Dr. Lydekker:† "The foregoing survey of such a large series of Mastodon molars has led to the conclusion that the very regular ridge formula given by Falconer will not always hold good in regard to the true molars,

* Vacek, Ueber Oesterreichische Mastodonten. Abh. der K. K. Geolog. Reichanstalt, vii, Heft iv, Wien, 1877. p. 45.

† Geological Survey of India, Series x, Vol. i, pt. v, 1880, p. 256.

though in the Indian species, at all events, it appears to be always constant in the milk-molars. We have seen that there is a tendency in the true molars of some of the Trilophodons (*M. falconeri*) to develop the talon into a fourth ridge, and in the Tetralophodons (*M. latidens* and *M. sivalensis*), a similar talon is developed into a fifth ridge, in the intermediate true molars." *M. humboldtii* Cuv. (*M. andium* Falc.*) shows a small fourth crest on the second true molar, according to Falconer.†

The lower incisor teeth, on which Godman relied for the definition of his genus Tetracaulodon, were shown by Harlan, not to be constantly present in the *Mastodon americanus*. In fact, no adult specimen has been described in which two inferior incisors are present. The single one observed is very rarely found in adults, being a character more frequently found in the young. It is in this species a remnant of a character elsewhere constant, which does not disappear quite so soon as the teeth of the whalebone whale, and superior incisors of the ruminant. But it is otherwise with other species referred to Mastodon. No specimens of the *Mastodontes angustidens*, *productus* and *longirostris*, are recorded, in which two inferior incisors are not present. For this reason the first and last-named were placed by Grant and others in the genus Tetracaulodon. Unfortunately this name was applied by its author to the *M. americanus* only, a species which cannot enter the genus furnished with a pair of persistent inferior incisors. It is also the type of Cuvier's Mastodon.‡ It thus unavoidably becomes a synonym of the latter.

There is no doubt that the presence of a pair of persistent inferior incisors defines a genus as distinct from one in which there is not a pair of permanent inferior incisors. I agree, therefore, with Grant and others, in separating the Mastodons which present this character from the genus Mastodon, under another generic head. I believe, also, that the presence or absence of a band of enamel on the superior incisors furnishes ground for the recognition of distinct generic groups, and would be so used in any other division of the Mammalia. It is often asked why it is necessary to multiply generic names on such grounds. My answer is simply an expression of the law governing the case, based on the supposition that when the species of animals and plants come to be fully known, the genetic series will be found to be uninterrupted, excepting by the presence or absence of characters which appear or disappear during the growth of a set of individuals, which we on this account call a species, or refer to a genus. The difference in the two cases consists in this: In the case of species, the characters are numerous and are matters of proportion, size, color, texture, etc., while in the case of the genus the character is single, and marks one step in the serial chain of structural modifications. In the case of the genus there is an actual addition or subtraction of some distinct

* Palæontological Memoirs of Falconer, i, p. 100, pl. 8.

† Loc. cit., ii, p. 15.

‡ Ossemens Fossiles, ii, p. 252, Ed. 1834: "Ann. Mus., 1806, viii, 272," teste Leidy.

part or piece of the organism.* If now we fail to notice these points or steps, we must abolish all genera. If we define some and fail to define others, our practice ceases to have the uniformity of a law, and we abandon the basis of scientific order.† One point, however, must be insisted on. In order that a character be usable for any purpose of definition, it *must define.* That is, it must belong to all the individuals referred to the species, genus, etc., defined, and must not be present in some individuals and wanting in others of those supposed to be defined by it. This being the case, adult animals only can be used for definition, as characters, especially generic, are added from time to time up to maturity. Sometimes only one sex can be considered, since the adult characters are in certain cases never reached by one sex or the other. This is often the case with insects. Moreover, some latitude for exceptional variations must be allowed. Thus, the exceptional absence of the last molar in a dog does not invalidate the definition of the genus Canis, M. $\frac{2}{3}$.

Of course, if all specimens of animals could be found, the definitions would all, or nearly all, be invalidated. But it is safe to assume that all the intermediate forms will not be found, so that the definitions of species will represent the state of our knowledge, and the results of the operations of nature in the preservation of individuals.

The case is somewhat different with regard to generic characters. As these involve the addition or subtraction of some part, having definite dimensions, it is quite possible to say when the latter is present or absent. Characters of this kind present the appearance of abruptness of transition, to which I have referred in my paper "On the Origin of Genera," and which gave rise to the formulation, by Professor Hyatt and myself, of the "laws of acceleration and retardation." When such change prevails throughout all the individuals of one or more species, a new genus has its origin. As a matter of fact, the creation of generic modifications has been exhibited, in the history of life, by many individuals nearly contemporaneously. As the change involves *but one character*, it offers a better opportunity for the formulization of the laws of evolution, than in the case of specific characters, which are more numerous.

The three genera of Elephantidæ, of which mention has been made above, will then be defined as follows:

Mastodon Cuv. Superior incisors without enamel band; inferior incisors wanting. Type *M. americanus.*

Dibelodon Cope. Superior incisors with enamel band; inferior incisors wanting. Type *D. shepardi.*

Tetrabelodon Cope. Superior incisors with enamel band; inferior incisors present in the male at least. Type *T. angustidens.*

To the genus Mastodon must be referred the following species. For

* See "Origin of Genera," Proc. Acad. Philada., 1869, where this point is discussed.

† American Naturalist, 1884, July, p.

the dental characters of the Indian species I am indebted to Messrs. Falconer and Lydekker :

Mastodon americanus Cuv., N. America.
" *?borsoni* Hays, E. and S. Europe.
" *mirificus* Leidy, N. America.
" *falconeri* Lydd., India.
" *arvernensis* C. & J., Europe.
" *sivalensis* Falc., India.
" *latidens* Clift., India.
Dibelodon shepardi Leidy, California, Mexico.
" *tropicus* Cope, Tropical America.
" *humboldtii* Cuv., South America.
Tetrabelodon angustidens Cuv., India, Europe, N. America.
" *andium* Cuv., S. America, Mexico.
" *productus* Cope, SW. N. America.
" *euhypodon** Cope, N. America.
" *pentelici* Gaudry, SE. Europe.
" *perimensis* Falc., India.
" *pandionis* Falc., India.
" *turicensis*† Schinz, Europe.
" *campester* Cope, N. America.
" *longirostris* Kaup, Europe.

The condition of the inferior incisors is unknown in the *Mastodon atticus* Wagner, and *M. serridens* Cope, and *M. proavus* Cope ; and in some of the above species the presence of an enamel band on the superior incisors has not been established.

I may add that I do not perceive how the so-called genus Stegodon can be distinguished, as at present, by the number of crests of the intermediate molars, and by the presence of cementum. It will probably be necessary to look for other characters in order to sustain it.

DIBELODON SHEPARDI Leidy.

Mastodon shepardi Leidy, Proceedings Academy Philadelphia, 1870, p. 98 ; 1872, p. 142.

Mastodon obscurus Leidy part, Report U. S. Geol. Survey Terrs. I, p. 330, Plate xxi.

This species was originally proposed on the evidence of a last inferior molar tooth from Contra Costa county, California, and a part of a superior tusk from Stanislaus county in the same State. Dr. Leidy subsequently abandoned the species. I however revived it in a synoptic table of the species of North American Mastodons in 1884. ‡

The fossils of the Museum Nacional of Mexico, examined by me, included

* American Naturalist, 1884, p. 525.

† Von Meyer is my authority for the presence of mandibular tusks in this species, = *M. virgatidens* Meyer.

‡ American Naturalist, 1884, p. 524.

a well-preserved lower jaw of a Mastodon, which presents both rami, and both the last true molars, and the entire symphysis. In the collection of the Ecole des Mines I saw a palate with the second and third true molars of both sides in place, and the superior incisor teeth, or tusks. Other fragments of jaws, with numerous isolated molars, were seen in these collections and in that of the college of the city of Toluca.*

From these specimens it is clear that the high valleys of Mexico were inhabited by a trilophodont mastodon, with a short decurved toothless symphysis like that of the *Elephas primigenius,* and with a band of enamel on the superior incisor tusks. The molars have the characters of those of the *Mastodon andium* of authors, and are of about the same size. The cross-crests are divided at the middle line only, and one half wears into a trefoil, while the other half wears into an oval, transverse to the long axis of the crown. The unworn crests are obtuse and not serrate; and there are no accessory tubercles besides those forming the lateral lobes of the trefoils. The size of the ramus and of the teeth is about that of the *M. angustidens,* and smaller than that of the *M. humboldtii.* The last inferior and last superior molars have but four cross-crests and a small heel. This I verified on several specimens.

A comparison of this species with those described, yields the following results: In the character of its molars it is identical with the *M. andium,* and differs from the *M. humboldtii* in the characters which distinguish the two species, as pointed out by Gervais.† That is, only one-half of each cross-crest wears into a trefoil, and the size is inferior. But it cannot be identified with the *Tetrabelodon andium,* because, according to Falconer,‡ that species possesses a long massive deflected beak containing an incisor tooth.‖ It is true that the specimen figured by Laurillard in D'Orbigny's voyage dans l'Amerique Meridionale, Pl. x, does not display a long beak and tusk, although the symphysis is much more pronounced than in the present species. But that plate is made from a drawing, and may thus be of doubtful authority. If correct, it may represent the female, or, as Falconer suggests, the young of the *T. andium.* The last inferior molar figured by Dr. Leidy, l. c., and formerly referred to a species under the name of *Mastodon shepardi,* has the character of the corresponding tooth of the Mexican species under consideration. The plate does not, however, represent the specimen satisfactorily in one respect. The trefoils are not sufficiently distinct, on account of the faint representation of their basal lobes. These nearly block up the cross valley, a fact not to be derived from an examination of the plate, but which is clearly seen in a cast preserved in the museum of the Philadelphia Academy of Natural Sciences.

* For the opportunity of examining the museum of this Institution I am much indebted to its President, Dr. Villada.

† In Castelnau's Expedition, 1855; Recherches sur les Mammiferes Fossiles de l'Amerique Meridionale, p. 14.

‡ Palæontological Memoirs, ii, pp. 226, 274.

‖ The lower jaw figured by Falconer, Mem. i. p. 100, from Buenos Ayres, as *M. andium* is clearly *M. humboldtii.*

This specimen also agrees with those in the Mexican museums in the small number of crests on the last inferior molar: four with a short rudimental heel. Another specimen of apparently the same species is described and figured by Leidy as having been brought from Tambla, Honduras.* This tooth is apparently anomalous in the contraction of the third cross-crest.

The range of this species may then be given as extending from California to the valley of Mexico, inclusive.

A species apparently allied to the *Dibelodon shepardi* is the *Mastodon serridens* Cope,† of which the typical specimen was brought from southwestern Texas. Premolar teeth of the same type were shown me by Professor Castillo, in the museum of the School of Mines. These came from a lignitic bed at Tehuichila, in the State of Morelos, of Loup Fork age. This epoch is indicated by the presence of the genera Protohippus and Hippotherium. The sharp, serrate edges of the crests distinguish the molar teeth from those of the *D. shepardi*, and as the species probably came from different horizons, they are probably distinct. A premolar mingled with those of *D. shepardi*, from the valley of Toluca, much resembles that of the *M. serridens.*

DIBELODON TROPICUS Cope, sp. nov.

Mastodon humboldtii? VonMeyer Palæontographica, 1867, Studien ueber das genus Mastodon, p. 64, Pl. vi. *Mastodon andium* Leidy, Proceedings Academy Philada., 1876, p. 38.

A second species of Dibelodon inhabited the valley of Mexico, of larger size than the *D. shepardi*, and differing somewhat in the dentition. Von Meyer describes and figures a ramus of a lower jaw, l. c., brought by Herr Uhde from Mexico, which has, according to Von Meyer, no mandibular tusk, and probably a short elephantine symphysis. A very similar ramus, containing the last molar tooth, was presented to the Philadelphia Academy of Natural Sciences by Dr. Isaac Coates, who obtained it from Tarrapota, on the Huallaga river, in Eastern Peru. The extremity of the symphysis of this specimen is broken away, but enough remains to show that it was probably short, and that there was no inferior incisor.

Reference to Von Meyer's figure shows that the last inferior molar has five well-developed cross-crests and a heel. The Peruvian specimen has the same character, the fifth cross-crest a very little more contracted than in Von Meyer's plate. Dr. Leidy describes the specimen as having four transverse ridges, besides a strong tubercular talon. But it seems to me that the talon is of such size as to be properly included in the cross-crests. On the same principle one might say that the *D. shepardi* has three cross-crests and a strong talon, as it has one less cross-crest than the *D. tropicus.* The additional cross-crest, and the superior size, distinguish this form as a species from the *D. shepardi.* Von Meyer perceived these differences, and referred his specimen to the *D. humboldtii.* I am fortunately able to

* Extinct Mammalia Dakota and Nebraska, Pl. xxvii, fig. 14.

† American Naturalist, 1884, p. 524.

make a comparison of his plate and the Peruvian jaw, with a well preserved jaw of the *D. humboldtii*, with perfect last molar and symphysis, from Buenos Ayres, in my collection. I am able fully to substantiate the characters already pointed out by Gervais, and to prove that the cross-crests of the molars form double trefoils, while those of the *D. tropicus* are like those of *D. shepardi* and the *Tetrabelodon andium*.

The species last named is said by Falconer (loc. sup. cit.) to occur in Mexico, and speaks of having seen a well preserved lower jaw from the State of Tlaxcala. I have not met with it.

The *Mastodon americanus* has not yet been found in Mexico. The most southern localities for the species known to me are Southern California, and near San Antonio, Texas. From the former region I possess a ramus with the last molar, presented to me by Mr. Scupham, of San Francisco; the other specimen was obtained from Mr. G. W. Marnock, of Helotes, near San Antonio, Texas.

ELEPHAS Linn.

ELEPHAS PRIMIGENIUS Blum.

This species, of both the thick and thin plated varieties, was once very abundant in Mexico. I have received a series of teeth from Candela, in the State of Coahuila, from Dr. Caspar Butcher, through my friend Dr. Persifor Frazer; and Von Meyer has pointed out the occurrence of its remains in the valley of Mexico. The museums of Mexico contain very numerous portions of skeletons of this species, which prove that it was far more abundant than the species of Mastodon. Up to this time this locality is the southern known limit of its distribution on the American continent.

APHELOPS Cope.

APHELOPS, sp. *Aphelops ?fossiger* Cope. Proceedings Academy Philadelphia, 1883, p. 301.

The right half of the mandible, with part of the symphysis of a rhinoceros, was found in the valley of Toluca, sixty miles west from the city of Mexico, and Dr. Barcena sent me a photograph of it a year ago. I published a notice of it as above cited, in connection with remarks on a rhinoceros skull which I obtained on one of the heads of the Gila river in New Mexico. On my recent visit to the College of Toluca, I had, through the kindness of Professor Villada, the opportunity of examining the jaw. Its characters do not differ much from those of the *Aphelops fossiger* Cope. It is considerably smaller, and has a very short diastema, but not shorter than in some jaws of the *A. fossiger*. The dimensions are as follows:

Measurements.	M.
Length of ramus from base of canine	.400
" " dental series with canine, less M. iii	.235
" " molar series, less M. iii	.200
" " true molars, less M. iii	.105

Measurements.	M.
Diameter of canine (transverse)	.027
" of P-m. ii	.007
Depth of ramus at P-m. iii	.070
" " " at M. i	.085
" " " at front of M. iii	.090

The matrix in which this jaw was found, is much like the Upper Pliocene material of Tequixquiac. It is therefore of probably later age than the true *Aphelops fossiger*, which is a characteristic Loup Fork species. Leidy describes (Extinct Fauna of Dakota and Nebraska, p. 230) a rhinocerus, probably an Aphelops, from California, under the name of *R. hesperius*. It is smaller than the Toluca specimen, but has a considerably longer diastema. Its geological horizon is uncertain.

I mention here that rhinoceroses, probably of the genus Aphelops, apparently existed in North America during the Pliocene period. Bones of a species having resemblances to the *A. fossiger* have been sent me by my assistant, George C. Duncan, from the Equus beds of the eastern part of the Oregon desert. The genus has been hitherto supposed not to ascend higher than the Loup Fork, or Upper Miocene beds. These bones are accompanied by teeth of a peculiar Hippotherium unlike those of any species of the genus known to me from the Loup Fork Miocene.

EQUUS Linn.

The remains of horses are very abundant in the valley of Mexico,* and represent four species. In the determination of these species it has become necessary to compare them with those hitherto found in North and South America. In making this comparison I exclude the species of Hippidium, which are all American, and whose molar teeth are easily distinguished by the equality in size of the internal columns; resembling in this respect the genus Protohippus.

When the species of the genus Equus differ in the characters of their superior molar teeth, the diversity is to be seen in the size and form of the anterior internal column. The anteroposterior diameter of this column, as well as the integrity or emargination of the internal border of its section, varies according to the species. The infolding or the borders of the lakes has a value, but a less constant one. The *Equus caballus* differs from all of the American extinct species, where the corresponding parts are preserved, in the great elongation of the face, which is expressed in the greater lengths of the diastemata anterior and posterior to the canine tooth in both jaws. Other characters may be observed in the relative lengths of the limb bones, the form of the occiput, etc. It has been shown by Leidy, Rütimeyer and others, that it is not always practicable to distinguish the species of horses by their teeth alone. A glance at Owen's

* This fact has already been made known by Von Meyer, Palæontographica, 1867, p. 70, and Owen, Transactions of the Royal Society, London, 1869.

plates of the dentition of the existing species of Equus*, shows the truth of this statement. Among the extinct species of Equus the range of variation is greater.

The following attempt at a discrimination of the species known to me, or so fully described as to be well known, must necessarily be regarded as provisional, until the skeletons are more fully recovered. American extinct species only are introduced :

I. Long diameter of anterior internal lobe of superior molars not greater than one third the long diameter of the crown.

Borders of lakes crenate ; internal anterior lobe notched on the inner side so as to be bilobate ; crowns a little curved ; large......*E. crenidens.*

II. Long diameter of anterior internal lobe more than one-third and not more than one-half the anteroposterior diameter of the crown.

α Crowns more or less curved.

Crowns wider than, or as wide as long ; enamel edges little folded........ *E. curvidens.*

$\alpha\alpha$ Crowns straight or nearly so.

β Diastemata longer.

Crowns nearly square, enamel not very complex ; no facial fossa ; maxillary bone produced much beyond M. iii.................*E. caballus.*

$\beta\beta$ Diastemata shorter.

γ No facial fossa.

Crowns nearly square ; enamel not very complex ; maxillary bone little produced behind last molar ; smaller..............................

E. hemionus ; E. burchelli ; E. quagga ; E. zebra ; E. asinus.

Crowns longer than wide on face ; enamel little complicated ; face and maxillary unknown ; large.........................*E. occidentalis.*

Crowns square ; enamel more folded than in other species ; face and maxillary unknown ; large..................................*E. major.*

γ A facial fossa.

Crowns nearly square ; enamel less complex ; maxillary short posteriorly ; smaller..*E. andium.*

III. Long diameter of anterior inner lobe more than half that of crown of molar teeth.

Crowns square ; enamel little complex (in Mexican specimens) ; diastemata and maxillary behind shorter ; no facial fossa ; large...*E. excelsus.*

Crowns square ; enamel little complex ; smallest species......*E. barcenæi.*

In using the above table it must be noted that gradations in the diameter of the anterior internal column (or lobe) exist, not only between individuals of the same species, but between different teeth in the same jaw. This diameter is always greatest in the last superior molar, and the characters of this tooth are such that they cannot be used in connection with the above table.

* Philosophical Transactions, 1869.

Before describing the Mexican species I make some notes on the others embraced in the above list:

Equus curvidens Owen. Of eight superior molar teeth from Buenos Ayres in my collection, two second premolars are perfectly straight, while the third true molar is the most curved. The other teeth exhibit different degrees of curvature. The area of the anterior internal column is not so flat on the inner side in any of them as in Owen's Plate (Voyage of the *Beagle*, Vol. i). My teeth have also a rather greater transverse diameter than Professor Owen's type.

Equus caballus L. The common horse differs from all of the extinct species of the genus from American localities where the muzzle is known, in the greater length of the latter, with its diastemata, of both jaws, and in the greater prolongation of the maxillary bone posterior to the last true molar. Appropriately to the anterior position of the molar series, the facial ridge commences above the middle of the first true molar. In an *Equus quagga* in my possession the ridge commences above the middle of the last premolar. The basioccipital bone is more compressed than in any species of the genus known to me.

Equus occidentalis Leidy. This species is represented in my collections by at least one hundred individuals, some of which have been lent me by my friend Professor Thomas Condon of the University of Oregon. They are nearly all derived from the Equus beds of the Oregon desert. Unfortunately there is no perfect skull. A few specimens from the same region I refer to the *Equus excelsus*, but as these are comparatively rare, I am safe in referring most of the bones to the other species. In these I find the following characters to separate the species from the *Equus caballus*: (1) The basioccipital bone is not compressed, and besides its inferior lateral angles it has a pair of lateral angles, one proceeding forwards from the inferior border of each *foramen condyloideum anterius*. (2) The fossa enclosed between the paroccipital process and the basioccipital, is deeper, and has a raised border in front which separates it strongly from the plane of the petrous bone. This is not found in *E. caballus*. I verify it in three separate occipital bones of the *E. occidentalis*. (3) The astragalus and other bones of the feet are smaller than in *E. caballus;* the first named intermediate in size between that of the horse and that of the quagga. The cannon bones, when of the same length, are more slender. (4) The inferior canine issues in direct contact with the last incisor, without the diastema seen in the horse; and the incisive arc is narrower and more produced. The symphysis is elongated not only forwards, but also posteriorly. The mental foramen is anterior to the bifurcation of the rami in *E. occidentalis*, posterior to it in *E. caballus*.

Equus major Dekay. Dr. Leidy leads us to infer (Report U. S. Geol. Survey Terrs., Vol. i, p. 244), that this species differs from the *E. occidentalis*, in the generally greater complication of the enamel folds. This I find to be the case in specimens from the Fish House, in the brick clay, near Philadelphia, and from the Big Bone Lick, Kentucky. Leidy figures similar specimens from various parts of the Eastern and Southern States.

EQUUS CRENIDENS Cope, sp. nov.

This large species of true horse is represented by molar teeth and fragments of jaws belonging to two individuals preserved in the Museo Nacional of Mexico, and to two others preserved in the Escuela des Minas. The typical specimen includes the three premolars of the upper jaw of an adult in perfect preservation.

The species is primarily distinguished by the close and strong wrinkling of the enamel border of the lakes of the superior molar teeth. This wrinkling, or vertical plication, reminds one of what is seen in the *Elephas indicus*. This wrinkling is not found in the enamel edges which border the interior crescents on the inner side, nor in those bordering the internal lobes or columns. The borders of the lakes are not folded in the complex loops seen in *Equus major* Dek., but have the plainer looping seen in the *Equus tau* Ow. The grinding faces are nearly square. That of the second premolar is a rather shortened triangle, and less produced anteriorly than in the *E. tau.* The crowns of the third and fourth premolars are long and slightly curved.

The measurements show that this is one of the larger species of horse.

Measurements. M.

Diameters of P-m. ii	anteroposterior	.0430
	transverse	.0305
Diameters of P-m. iii	anteroposterior	.0335
	transverse	.0340
Diameters of P-m. iv	anteroposterior	.0310
	transverse	.0350

The crimping of the enamel of the lakes distinguishes this species from the others of the genus.

From Tequixquiac.

EQUUS TAU Owen. Philosophical Transactions of the Royal Society, 1869 ; p. 565 ; pl. lxi ; fig. 4.

Of this species there are preserved in the Museum Nacional five superior molars, some of which belong apparently to one individual. In the Escuela des Minas, the series is a fine one. There are two skulls lacking the occiput ; one skull lacking the occiput and muzzle ; parts of both maxillary bones with teeth, of one skull ; and a single maxillary bone with teeth, of a fifth skull. The specimen mentioned under the second head, has teeth and palate preserved, as in the figure given by Owen of his *Equus conversidens,* and I suspect it was from this specimen that the photograph was taken from which Professor Owen's figure and plate were made. It is possible that his figure and description of the *Equus tau* were made from one of the maxillary bones mentioned under head three. I am not able to perceive the specific differences between these specimens. The character displayed by Owen's *E. conversidens*, on which he relied to distinguish the species, may be the result of distortion. The maxillary bones of the type are loose and may be made to assume different angles to each other. The last superior molar is represented as unusually short by Owen. This appearance could be produced by the oblique angle of the aperture of the camera in photographing, due to its too anterior position. Be that as it may, I could detect no specific differences between the seven or eight specimens I examined.

The *Equus tau* is an average horse in all respects, presenting no very tangible characters by which to distinguish it from the existing species of the *E. asinus* and *E. zebra* group, so far as the parts which I examined go. It has the internal anterior column of the superior molar always less in diameter than half that of the crown of the tooth, and not characterized by any marked peculiarity. The borders of the lakes have an entering loop on each end of the inner border; of these the adjacent ones are well marked, and the remote ones little marked. External to the adjacent loops the borders of the lakes are a little crenate. There is a small internal median loop of the internal enamel border at the notch. The crowns of the teeth are a little wider than long, and they are not curved. The palate notch reaches as far forwards as the posterior border of the second true molar, and the palatal foramen is opposite the front of the third true molar. The latter tooth is a little longer than the other true molars. The second premolar is short and robust. The diastemata are rather short, as can be seen by the appended measurements.

Measurements.		M.
No. 1. Escuela des Minas.		
Length of precanine diastema		.020
Length of postcanine diastema		.074
Length of molar series		.151
No. 2. Museum Nacional.		
Diameters of P-m. ii	anteroposterior	.030
	transverse	.024
Diameters of ?P-m. iii	anteroposterior	.024
	transverse	.027
Diameter of ?P-m. iv	anteroposterior	.025
	transverse	.028

This species differs from the *Equus andium* Wagn., so fully described by Branco,* in the absence of a facial fossa. From *Equus caballus* it differs in the short diastemata, and the little posterior production of the maxillary bone. How it differs from the species of the *asinus* section I do not yet know.

EQUUS EXCELSUS Leidy, Extinct Mammalia Dakota and Nebraska, 1869, p. 266; pl. xxi, fig. 31.

*In Dames and Kayser Palæontologische Abhandlungen, 1883, p. 110, Dr. Branco furnishes reasons for believing that the *E. argentinus* Burm. is the same species

A portion of a left maxillary bone supporting the true molars of a horse from the Oregon desert, received from Professor Condon, resembles closely the type specimen from Nebraska described by Leidy as above. Two skulls, in the two museums of Mexico already referred to, present the same dental characters. In identifying the Mexican with the Oregon and Nebraska horses, I wish to be understood as making a provisional arrangement only, for unfortunately the cranium of the North American horse with this dentition is yet unknown. The uncertainty attending a dental identification being admitted, I proceed to the description.

This species differs from the others, whose remains have been found in the valley of Mexico, in the elongate and flattened form of the lobe formed by the section of the anterior internal column of the superior molar. This long diameter generally exceeds the half of that of the crown of the tooth by one-eighth the latter, and is rarely so short as one half of the same. The loops of the lakes are few, including only one near the posterior borders near the internal side and one on the anterior border of the posterior lake. There is generally a little loop at the notch between the two internal lobes. Crowns straight, second superior premolar elongate and acute.

One of the crania is complete, lacking only the lower jaw, and the two third true molars. The other lacks all posterior to the palatal notch. From the former I derive the following characters :

The apex of the nasal bones is above the superior canine tooth. The posterior border of the nares marks the middle of the anterior column of the third premolar. The infraorbital foramen is above the posterior edge of the second column of the fourth premolar. There are two notches on the anterior part of the superciliary border ; and there is a short exostosis on each side of the front, in line with the supraorbital border, in front of the preorbital border.

Measurements.		M.
Length from superior edge of foramen magnum to incisive border		.565
From posterior nares to incisive border		.300
Interorbital width		.166
Length of series of molar teeth		.191
" precanine diastema		.022
" postcanine "		.056
Width of palate at third incisors		.092
" " canines, inclusive		.075
Diameters P-m. ii	anteroposterior	.0425
	transverse	.0275
Diameters P-m. iii	anteroposterior	.032
	transverse	.034
Diameters M. iii	anteroposterior	.0335
	transverse	.029

The internal anterior column of the superior molars is longer and flatter than in the specimens of the North American horse, but I do not feel at liberty to propose a new specific name for the Mexican animal. The absence of facial fossa and short diastemata throw it into the series of the asses. From all these the large flat internal column distinguishes it. The presence of the loop at the notch of the internal border in the Mexican specimens distinguish them from Leidy's type and from one of Condon's specimens. A second one of the latter has a small loop at the point in question. The absence of this loop is given by Leidy as characteristic of the *E. occidentalis*, but only a small proportion of my specimens of that species are without it.

The Mexican specimens are from Tequixquiac.

EQUUS BARCENÆI Cope, sp. nov.

Two superior molars represent this species in the Museum Nacional, and two superior molars in the Escuela des Minas. A skull lacking all in front of the orbits inclusive, in the latter museum, probably belongs to the same species.

This horse is distinguished from all the others here mentioned or described by its small size. In the characters of its superior molars it is like the *Equus excelsus*. The anterior internal column is flat, and its anteroposterior diameter is five-eighths that of the crown of the tooth. The prism is straight. The lakes have the margin but little looped; the posterior notch of the anterior lake is trebled or triplex. The grinding face of the crown of the third superior molar is a little longer than the others.

Measurements.		M.
Diameters of molar No. I	anteroposterior............	.0215
	transverse.................	.0230
Diameters of molar No. II	anteroposterior............	.022
	transverse.................	.022

From Tequixquiac.

I have dedicated this species to my distinguished friend Mariano de la Barcena, Professor of Geology in the National Museum and Director of the Meteorological Observatory of the City of Mexico.

PLATYGONUS Leconte.

PLATYGONUS ? COMPRESSUS Leconte.

A portion of the mandibular ramus of a species of peccary, apparently the above, was found at Tequixquiac, and is preserved in the museum of the College of Guanajuato. Dr. Alfredo Dugés, the distinguished professor in the college, called my attention to the specimen, and gave me a cast of it. Its dimensions are similar to those of North American individuals, as follows :

Measurements.		M.
Diameters of M. i	anteroposterior.....	.0145
	transverse	.012

Measurements.		M.
Diameters of M. ii	anteroposterior	.017
	transverse	.014

HOLOMENISCUS, gen. nov.

Under the head of this genus I give a synopsis of the results of my study of the extinct Camelidæ of the American Pliocene epoch. I can compare the specimens from Buenos Ayres with those from Mexico and Oregon, and Branco and Owen have given detailed descriptions of specimens from Buenos Ayres and Mexico. From these sources I learn of the existence of the following generic forms of Camelidæ. I omit Protolabis Cope,* and refer it to a separate family—the Protolabididæ, on account of the presence of three superior incisors in each premaxillary bone, as in the primitive Ruminantia, combined with the presence of a cannon bone.

I. Premolar teeth $\frac{4}{4}$.

P-m. i separated by diastemata.................................*Procamelus.*

II. Premolar teeth $\frac{4}{3}$.

P-m. ii below wanting...*Pliauchenia.*

III. Premolar teeth $\frac{3}{2}$.

Fourth inferior premolar triangular... ....*Camelus.*

Fourth inferior premolar composed of two crescents, which enclose a lake (an inferior P-m. 3?)..................................*Palauchenia.*

Fourth inferior premolar composed of two crescents, with two posterior tubercles behind them..............................*Protauchenia.*

IV. Premolar teeth $\frac{2}{1}$

Fourth premolar below triangular................. ....*Auchenia.*

V. Premolar teeth $\frac{1}{1}$

Fourth superior premolar composed of two crescents.......*Holomeniscus.*

Fourth superior premolar consisting of a simple cone..........*Eschatius.*

The position of this genus being determined as above, it remains to examine the material representing it, at my disposal.

In 1873 Dr. Leidy† described a large species of llama from specimens from California, which include the entire inferior series of molar teeth, and one superior molar. The first inferior molar, properly the fourth premolar, has the crown partially worn, showing that it was opposed by a grinding tooth in the superior series. In the Museum Nacional of Mexico is preserved a complete mandibular ramus, containing all the teeth of one side of an animal smaller than Dr. Leidy's type, but having a general resemblance to it; including the worn fourth premolar. In the collections of Professor Condon and myself from the Oregon desert, there are various isolated molars agreeing in measurements with Dr. Leidy's type, and belonging probably to the same species. In the Condon collection is part

* Proceedings Academy Philadelphia, 1876, p. 145.

† Report U. S. Geol. Survey Terrs., F. V. Hayden, i, p. 255, pl. xxxvii, figs. 1–3.

of a superior maxillary bone which contains the M. i and the alveolus of the P-m. iv, with the foramen infraorbitale anterius. The measurements of the M. i agree with those of the corresponding tooth of the lower jaw of Leidy's specimen. In the Museum of Mexico, there are preserved several superior true molars which also agree in dimensions with the corresponding teeth of the lower series of the type of the same *A. hesterna* of Leidy. The fourth superior premolar is wanting from this series.

The fragment of maxillary bone in the Condon collection shows that this species had a large three-rooted fourth premolar. It is broken off at the anterior alveolus, but it is so attenuated at that point as to make it almost certain that there was no third premolar in front of it, as is found in the genus Auchenia.

In further evidence of the existence of a genus characterized as above, by the absence of the P-m. $\frac{3}{}$, the jaw-fragment which represents the *Auchenia vitakeriana** may now be cited.

Holomeniscus vitakerianus Cope.

Although I ascribed a third superior premolar to this species, I must now deny its existence in the adult animal. A slight fossa on the narrow alveolar ridge indicates the possible presence of a single-rooted rudiment of such a tooth in the young. In a comparison of this species with the *Auchenia weddellii* Gervais, from the Pampean beds of Buenos Ayres, it is readily observable that the latter is a true Auchenia, with well developed P-m. 3 in the upper jaw, and that it is of larger and more robust proportions than the *H. vitakeriana*. In the only well preserved lower jaw which I possess, there is a well developed P-m. iii, a tooth found only as an occasional accident in *Auchenia lama* (teste Owen Odontography). In the *A. intermedia* Gerv., from the same locality, this tooth is wanting from one ramus, while the other displays a shallow vacuity as though such a tooth had existed in infancy and had been shed. I therefore retain these species in Auchenia.

HOLOMENISCUS HESTERNUS Leidy. *Auchenia hesterna* Leidy, loc. sup. cit.

The existence of superior molars in the Museum Nacional of Mexico which agree with the corresponding teeth of the Californian and Oregonian llamas has been mentioned above. I give the dimensions of these teeth as follows :

Measurements.			M.
Diameters M. i		anteroposterior	.041
		transverse	.033
Diameters M. ii	one individual.	anteroposterior	.041
		transverse	.040
Diameter M. iii		anteroposterior	.053
		transverse	.029

* Bulletin of the U. S. Geological Survey Terrs., 1878, p. 380.

These molars are covered with a layer of cementum, which is included in the measurements.

The mandible, I am disposed to refer to a smaller variety of this species for the present. The well-worn fourth inferior premolar indicates that it could not belong to the genus Eschatius, where there is no opposing tooth in the superior series capable of producing such a result. The hook below the condyle is well developed in this jaw. The incisor teeth are narrow. The canine is small and is separated from the incisors by a diastema. The triturating surface of the fourth premolar is triangular, and includes a lake. The molars increase in size posteriorly. The mental foramen is large, and is situated behind a point below the canine.

Measurements.		M.
Length of jaw from incisive alveoli to angle		.415
Height at coronoid process		.290
" at condyle		.218
" ramus at M. i		.070
" " " middle of diastema		.040
Length of symphysis		.096
" from base of incisors to canine		.043
" " canine to P-m. iv		.092
" of all the molars		.147
Diameters P-m. iv	anteroposterior	.022
	transverse	.013
Diameters M. i	anteroposterior	.035
	transverse	.019
Diameters M. ii	anteroposterior	.042
	transverse	.019
Diameters M. iii	anteroposterior	.048
	transverse	.016

From Tequixquiac.

A cannon bone in Condon's collection, which may belong to this species, measures fifteen and a quarter inches in length. So far as the evidence goes it may as well have belonged to the *Eschatius conidens*. According to Leidy the cannon bone of the *Auchenia californica* Leidy measures nineteen inches in length. A cannon bone of at least this size, with other bones of the skeleton, occurs in the museum of the School of Mines, and may belong to the Californian species. Whether that species is a true Auchenia or not remains uncertain, as the teeth are unknown.

ESCHATIUS, gen. nov.

This genus is well characterized by the reduction of the fourth superior premolar to a simple cone, in place of the usual double crescent characteristic of the Ruminantia generally. This is the greatest known reduction of the premolar series in the Ruminantia, exceeding anything in the Bovidæ, a family otherwise more specialized than the Camelidæ. If my identification of mandibles be correct, there is but one inferior premolar, which is not prismatic, but has two divergent roots as in Auchenia. The crown is compressed. In any case this genus is distinct from Palauchenia Owen, which is said to have the fourth inferior premolar composed of two crescents, somewhat as in the Protauchenia of Branco. There is also a simple conic third inferior premolar according to Owen. The type specimen of the type of Palauchenia, *P. magna* Owen, consists of isolated teeth put together in a bed of plaster of Paris. While there may be some uncertainty as to the position of the third premolar, I cannot agree with Professor Leidy* in the supposition that these teeth have been inverted by their describer, and really belong to the upper jaw. The specimen is preserved in the museum of the School of Mines, and I did not observe any second one.

ESCHATIUS CONIDENS, sp. nov.

Primarily established on a superior maxillary bone, which contains all its teeth, which is preserved in the Museum Nacional of Mexico. I cannot distinguish from this individual another one which was found by Mr. C. H. Sternberg in the desert of Oregon, and which is represented by a good many fragments, including parts of both jaws. I describe the Mexican specimen first.

The true molars increase rapidly in size posteriorly. The vertical ribs of the external anterior horns of the external crescents are very strong, and the external wall of the anterior crescent has a low rib on the median line also. The posterior internal crescent of the last superior molar (which is not much worn) sends its anterior horn to the external wall, thus cutting off the posterior horn of the anterior internal crescent.

Measurements.		M.
Length of the four superior molars		.126
" " M. i		.041
Diameters of M. ii	transverse at base	.024
	anteroposterior	.044
Length of M. iii		.051

The *foramen infraorbitale anterius* issues above the anterior rib of the posterior crescent of the first true molar. The specimen is from Tequixquiac.

The Oregon specimen includes a left maxillary and mandibular bones, with the roots or alveoli of the teeth remaining, together with numerous bones of the skeleton. As one or two teeth of the *Holomeniscus hesternus* are mingled with the other pieces, it becomes uncertain to which of the species some of the bones should be referred. This is the more difficult, as the superior molar teeth of the two animals are of nearly the same dimensions. The probabilities are, however, that the greater number accompany the species represented by the jaws. I proceed to describe the latter.

In the maxillary bone the single alveolus of the fourth premolar is close

* Report U. S. Geolog. Survey Terrs. I, p. 256.

to that of the anterior root of the large first true molar. Its section is a wide oval. The base of the second true molar is not longer than that of the first true molar. The external wall of the maxillary bone is broken so that the position of the infraorbital foramen cannot be positively ascertained. A narrow groove, which may be a part of the infraorbital canal, is exposed, and is continued forwards to a point anterior to the first premolar, where it probably issues. If this be a correct inference, its position is anterior to that observed in the Mexican specimen. The palatine foramen issues opposite the anterior root of the first true molar. In the *Holomeniscus hesternus* this foramen issues opposite the fourth premolar's internal root.

The fragment of mandible is the anterior part of the left ramus, including the premolar and half the symphysis. The fundi of the anterior alveoli only are preserved. That of the canine is smaller than those of the incisor teeth, and is close to that of the external incisor. The mental foramen is large, and is situated posterior to the mouth of the alveolus of the canine. The symphysis is not coössified. The alveolar edge of the diastema is narrow, and presents a narrow vertical parapet outwards, which makes an angle with the external convex side of the ramus. The inferior outline below the diastema is a little concave. The roots of the premolar are well separated. The crown is lost. The coronoid process, supposed to belong to the same species, is like that of the llama, near the condyle, and is quite elevated. It maintains its anteroposterior width to near the summit. Anterior edge rounded, the bevel extending on the external face towards its base. The posterior rotula of the condyle is median, and not on one side as in the llama and in the camel. The anterior part of the face presents forwards as in the llama, and is not so much expanded as in the camel. The petrous bone is as large as that of the camel, and has a more widely open styloid fossa, which is directed more inwards in the downwards direction. The face also for the paroccipital process approaches much more nearly to its fundus than in either the camel or the llama.

Measurements.	M.
Long diameter of alveolus of superior P-m. iv	.009
" " " " M. i	.036
" " " " M. ii	.038
" " " inferior P-m. iv	.022
Length of inferior postcanine diastema	.070
Depth of ramus at middle diastema	.035
" " P-m. iv	.045

It still remains to be ascertained whether this Oregon Eschatius belongs to the species that is found in the Pliocene beds of the valley of Mexico.

Eschatius longirostris, sp. nov.

This llama is known to me from a right mandibular ramus, which is broken off behind the last molar tooth, and which supports the symphyseal portion of the left ramus, less its external wall. In size this species is between the *Auchenia weddelli* Gerv. and the *Eschatius conidens*, having just about the dimensions of the *Camelus dromedarius* or the *Palauchenia magna* Ow. It differs from the *Eschatius conidens* in the much longer inferior diastema, longer, coössified symphysis, and smaller true molar teeth ; the comparison being made with superior molars of the *E. conidens*.

The alveolus of the inferior canine tooth is small, and is a short distance posterior to the third incisor, being separated by a short diastema. The mental foramen is very large, three times the size of that of the *E. conidens*, and its anterior edge is 20 mm. posterior to the canine alveolus. The alveolar parapet of the diastema is not so elevated as in *E. conidens*, but is distinct. The dentition shows that the animal is an old one. The fourth premolar has two divaricate roots, which spread nearly as far anteroposteriorly as those of the first true molar. The crown is compressed. Apex broken. The crowns of the molars are worn ; that of the first to the roots. The heel of the third true molar is lost.

Measurements.	M.
Width of mandible at inferior canines	.027
Length of inferior postcanine diastema	.110
" " molar series	.132
" " P-m. iv	.027
" " M. i	.029
" " M. ii	.034
Width of " M. ii	.022
Depth of ramus at middle diastema	.043
" " P-m. iv	.058

From the Oregon desert ; Professor Condon's collection.

BOS Linn.

Bos latifrons Harlan.

This species is represented by numerous remains, and must have been abundant in Mexico during the Pliocene epoch.

On the structure of the feet in the Extinct Artiodactyla of North America. By E. D. Cope.

(*Read before the American Philosophical Society, August 15, 1884.*)

The structure of the feet of a number of the Artiodactyles of the Tertiary beds of North America has already been described. In this paper I enumerate these, and add descriptions of some types which have been hitherto unknown. I commence with the Bunodonta.

Bunodonta.

Pantolestes Cope.

The structure of the tarsus only of this Eocene genus is known.*

* Cope, Proceedings American Philosophical Society, 1881, p. 188. Pal. Bulletin, No. 34.